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**WHAT IS CLAIMED IS:**

1 1. A membrane structure comprising a silicon film having a  
2 grain structure including grains defining pores therebetween.

3  
4 2. A membrane structure comprising a silicon film including  
5 grains having gaps formed therebetween to define individual  
6 pores, the maximum cross-sectional dimension of any one grain  
7 approximately equal to the thickness of the film.

8  
9 3. The structure of claim 2 wherein a lateral dimension of  
10 any pore is less than that of any grain.

11  
12 4. The structure of claim 2 wherein a lateral dimension of  
13 the pores is between about 10 and 50 nanometers.

14  
15 5. The structure of claim 2 wherein the thickness of the  
16 film is less than or equal to about 150 nanometers.

17  
18 6. The structure of claim 2 wherein the thickness of the  
19 film is between about 50 and 150 nanometers.

20  
21 7. The structure of claim 2 wherein the roughness of the  
22 film is approximately equal to its thickness.

23  
24 8. The structure of claim 2 wherein the film forms a filter.

25  
26 9. The structure of claim 2 wherein the film is conformal to  
27 an underlying surface.

28

10. The structure of claim 2 further including a structural layer to support the film.

11. The structure of claim 2 further including a conformal layer formed on the film to provide a selected chemical or biological function.

12. A membrane filter structure comprising a silicon film having a grain structure including grains defining pores therebetween, a lateral dimension of the pores being between about 10 and 50 nanometers and the maximum diameter of any one grain not exceeding the thickness of the film.

13. A method of fabricating a membrane structure comprising:  
forming a sacrificial layer over a first surface of a substrate;  
forming a silicon layer over the sacrificial layer such that the silicon layer has a grain structure including grains defining pores therebetween wherein the maximum diameter of any one grain does not exceed the thickness of the membrane structure; and  
removing the sacrificial layer.

14. The method of claim 13 further including forming a passageway through the substrate.

15. The method of claim 13 further including forming a conformal layer over the silicon layer to provide a selected chemical or biological function.

16. A method of fabricating a membrane structure comprising:

60 forming a sacrificial layer over a surface of a  
61 substrate;  
62 forming a structural layer over the sacrificial layer;  
63 forming a silicon layer over the structural layer such  
64 that the silicon layer has a grain structure including  
65 grains defining pores therebetween wherein the maximum  
66 diameter of any one grain does not exceed the thickness  
67 of the membrane structure; and  
68 removing the sacrificial layer.  
69

70 17. A method of fabricating a membrane filter structure  
71 comprising:

72 forming a sacrificial layer over a first surface of a  
73 substrate;  
74 growing a silicon film over the sacrificial layer at a  
75 temperature near the tensile-to-compressive transition  
76 temperature of the silicon film such that the silicon  
77 film has a grain structure including grains defining  
78 pores therebetween wherein the maximum diameter of any  
79 one grain does not exceed the thickness of the membrane  
80 filter structure; and  
81 removing the sacrificial layer  
82

83 18. The method of claim 17 wherein the silicon film is  
84 formed under a near zero-stress condition.  
85

86 19. The method of claim 17 wherein the silicon film has a  
87 residual stress within a range of about -50 to 50 mega-  
88 Pascals.  
89

90 20. The method of claim 17 wherein the silicon film has a  
91 residual stress within a range of about -100 to 100 mega-  
92 Pascals.

93  
94 21. The method of claim 17 wherein the silicon film is grown  
95 such that a lateral dimension of any pore is less than that of  
96 any grain.

97  
98 22. The method of claim 17 wherein the silicon film is grown  
99 such that a lateral dimension of the pores is between about 10  
100 and 50 nanometers.

101  
102 23. The method of claim 17 wherein the silicon film is grown  
103 such that the thickness of the film is between about 50 and  
104 150 nanometers.

105  
106 24. The method of claim 17 wherein the silicon film is grown  
107 such that the roughness of the film is approximately equal to  
108 its thickness.

109  
110 25. The method of claim 17 further including forming a  
111 conformal layer on the silicon film to provide a selected  
112 chemical or biological function.

113  
114 26. The method of claim 17 further including monitoring the  
115 residual stress of the silicon film.